GLASS-CERAMIC PLATE AND ITS MANUFACTURING PROCESS

The present invention relates to a glass-ceramic plate intended notably to cover or receive heating elements, in particular intended to be used as a cooking plate (or hob), the heating elements associated to this plate being, for example, halogen or radiant heat sources or induction heaters or atmospheric gas burners.

The sales of glass-ceramic plates have been constantly increasing in recent years. This success is explained in particular by the attractive appearance of these plates and by the ease with which they are cleaned.

It will be recalled that a glass-ceramic is initially a glass, called precursor glass, the specific chemical composition of which makes it possible to induce controlled crystallization by suitable heat treatments, called ceramification treatments. This specific partly crystallized structure gives the glass-ceramic unique properties.

At the present time there are various types of glass-ceramic plates, the appearance of which may vary according to the type of heating employed or the application: white or black plates, exhibiting local deformations (support pads), curved or straight shapes, inclined edges, etc. Each variation is the result of extensive studies and many trials, given that it is very difficult to make modifications to these plates (for example to their shape or to their composition) and/or to the process for obtaining them (change of temperature for example) without running the risk of an unfavorable effect on the desired properties (solid structure, heat shock resistance, smooth appearance, high transmission for wavelengths in the infrared range and low transmission for wavelengths in the visible range, without thereby masking the heating elements in the operating state for safety reasons, etc.).

In particular, it is very difficult to conceive plates with surface variations or interruptions for fear of mechanical strength problems and/or heat shock resistance problems and/or flatness problems, etc., it being possible that any dimensional, positional or shape changes in these variations or discontinuities compared with already approved plates will mean that these plates do not comply with the requirements associated with their use.

In particular as regards openings, the openings most frequently produced consist of small openings of rounded shape, which are necessary for the operation of certain functional areas of the plate, namely openings for atmospheric gas burners or for knobs or levers. Patent

Application EP 0 879 797 also discloses a process for obtaining openings for atmospheric gas burners at the top of a local deformation of the plate. This combination of a local deformation of the plate and an opening has, however, never been envisaged for openings of different sizes or different shapes because of the abovementioned fears and risks.

The aim of the present invention is to develop a novel type of glass-ceramic plate allowing the range of existing products to be enlarged and providing novel functions, without the modifications made having deleterious effects on the desired properties of the plates, this plate remaining practical in use and easy to clean, and posing no manufacturing or processing problems.

The novel plate according to the invention is a glass-ceramic plate intended, for example, to cover or receive heating elements, and is characterized by the presence of at least one opening located within a local deformation of the plate, this opening being at a location other than a heating area and/or having at least one dimension greater than 10 cm and/or an angular and/or complex shape. According to a preferred embodiment of the invention, the plate is advantageously provided or combined, or intended to be used, with a suction hood allowing in particular the extraction of cooking gases.

The term "glass-ceramic plate" is understood hereafter to mean not only plates made of glass-ceramic itself, but also plates made of any other similar material that is resistant to high temperature and has a zero or almost zero expansion coefficient (for example less than 15×10^{-7} K^{-1}). Preferably however, this is an actual glass-ceramic plate. The invention is also not limited to the manufacture of plates for cookers or cooktops, but may also relate to other plates that have to be very insensitive to temperature variations.

In accordance with the definition of the invention, the plate is distinguished from existing plates by an opening (or cut-out) combined with local deformation of the plate, it being differentiated, in terms of location and/or size and/or shape, from existing plates.

The opening according to the invention is therefore an opening made within a local deformation of the plate. In other words, the opening is in a plane other than the main plane of the plate, and generally above said main plane. Also in general, the opening is at the top of the local deformation, and in a plane parallel to the main plane of the plate. The wall or walls defining the deformation (and likewise defining in general the opening) may be vertical or inclined, plane or curved, depending on the

process used, as will be explained later. The combination of the opening and the deformation affords many advantages in terms in particular of sealing or spill-proof, ease of operation and ease of cleaning. It allows, among other things, a defined orientation of the flow, where appropriate, of liquids (reduced risk of leaking of liquids into the opening especially owing to the raising of the opening), as well as good mechanical protection of the opening, and without this being to the detriment of the ease of cleaning the device, it being possible to clean it right to the edge of the opening (especially owing to the fact that there is a continuous variation of the plate). Furthermore, if a protection element is associated with the opening, such as a grid, in order to prevent objects from falling into it, as will be indicated later, it is unnecessary to seal between it and the plate, for example by suitable gluing or bonding, thereby especially simplifying the operations of fitting these various elements together.

Preferably, the height of the opening relative to the main plane of the plate is at least 2 mm, in particular around 4 mm.

According to a first embodiment of the invention, the opening coupled with the deformation differs from what exists as regards position, and in particular is at a position other than a heating area. The term "heating area" is understood to mean the area covering a heating element (the term cooking area may also be used). It is also advantageously at a position other than a control area (that is to say outside the position of a control element) of a heating area. It is also preferably located other than at the edge of the plate. In particular, the opening is preferably at least 35 mm, advantageously at least 40 mm, from the edge and/or from each heating area and/or each aforementioned control area of the plate. In a particularly preferred embodiment of the invention, the opening according to the invention occupies a position mid-way between the cooking areas, generally it is in a central area of the plate.

In a second embodiment of the invention, at least one dimension of the opening (width, length, diameter, etc.) is greater than 10 cm, or even at least one dimension is greater than 20 cm or, where appropriate, the width and the length of the opening are greater than 10 cm. There was a negative a priori to make an opening in combination with a deformation as large as this for the abovementioned reasons, in particular through fear of ceramification problems or problems having repercussions as regards the flatness of the plate or its strength characteristics. The present invention, in conjunction with the processes described later, demonstrates that none of this is so, the departure from flatness obtained (apart from the desired

deformations) notably not exceeding 0.2 mm on plates according to the invention.

In the same way, with regard to the third embodiment of the invention, there was a negative a priori about obtaining an opening, in combination with a deformation, having a polygonal or angular shape, or complex (non-geometrical) shape, with a regular and satisfactory appearance, in particular at the corners. Now, the openings according to the present invention, in conjunction with the processes described later, may very well have reproducible angular shapes (in particular a rectangular shape), of clearly defined and well designed appearance, with generally rounded, clearly defined and reproducible angles, these angles possibly being further refined, for example by an additional shaping operation. The opening according to the first two embodiments may also have other shapes, particularly oval or circular shapes.

In general, at least one part of the edge of the opening according to the invention is shaped (preferably so as to have a rounded profile without sharp angles) so as, in particular, to eliminate if necessary any risk of mechanical weakening.

The plate may also be equipped with at least one seal, especially at the opening, such as a fibrous annular seal, for example providing additional impermeability to liquids and/or providing where necessary the mechanical interface between the glass-ceramic plate and the associated through-element, while avoiding direct contact and preventing any risk of scratches or shocks.

According to the invention, the plate is preferably provided or combined, or intended to be used, with at least one suction hood, this hood cooperating with the defined opening according to the invention, generally in a middle or central position relative to the cooking areas and/or relative to the plate. In a preferred embodiment, the opening is in the form of a rectangular cut-out, having for example a width of the order of several centimeters, notably around ten centimeters, and a length of about ten to several tens of centimeters, for example around thirty centimeters.

The hood is preferably added beneath the plate (or the plate is positioned above the hood) in its operating position so as, where appropriate, to be masked by the cooking appliance on which the plate has to be mounted. Advantageously, the opening or cut-out is covered with a protective element preventing objects from falling through it, such as saucepans, while allowing the passage of cooking gases and their suction by the hood, for example the opening is covered with a grid or with a mesh

cover, as illustrated in particular later, it being possible for this element to be simply positioned and not needing to be fastened by bonding, as explained above.

The plate according to the invention may have several openings, including at least one as defined according to the invention and, optionally, one or more other openings, for example for burners and/or knobs or levers. However, the degree of coverage of the plate (solid parts in the plane of the plate) preferably represents at least 60%, generally at least 75%, of the surface area of the plate. The plate may have various shapes (generally rectangular shapes), local deformations (hollows and/or reliefs, such as studs, a separating line or "wave", for example for the control strip, etc.) and may also have a lower face provided with prongs or teeth for mechanical reasons, etc. The plate according to the invention may be provided with functional or decorative elements, generally added elements, such as one or more connectors and/or cables, one or more cooking or temperature-maintaining means and one or more associated control means. Apart from the advantages explained above, the plate according to the invention is particularly simple and inexpensive.

The invention also relates to appliances or devices for cooking and/or for maintaining a high temperature (cookers, set-in hobs, etc.) comprising at least one plate according to the invention and having, where appropriate, one or more heating elements such as one or more radiant or halogen elements and/or one or more atmospheric gas burners and/or one or more induction heating means. The invention covers cooking appliances having a single plate and appliances having several plates, each of these plates having a single heater (cooking spot) or multiple heaters. The invention also relates to mixed cooking appliances whose plate or plates have several types of heater (such as gas heaters, radiant heaters, halogen heaters or induction heaters). The plate according to the invention may, in a known manner, be mounted on or set in a support or work surface, such as the work surface of the cooker (or cooktop) or the casing of a cooker. The plate may be surrounded by a frame and/or may have free edges that are generally shaped (rounded, beveled, etc.).

The subject of the invention is also a process for manufacturing a plate according to the invention. The reader is reminded that the manufacture of glass-ceramic plates generally takes place as follows: the glass of composition chosen to form the glass-ceramic is melted in a melting furnace, the molten glass is then rolled into a standard sheet or strip, by making the molten glass pass between rolling rolls, and the glass

strip is cut to the desired dimensions. The plates thus cut are then ceramified in a manner known per se, the ceramification consisting in baking the plates according to the chosen thermal profile for converting the glass into what is called the "glass-ceramic" polycrystalline material which has a zero or almost zero expansion coefficient and is able to withstand a heat shock possibly up to 700°C. The ceramification operation generally comprises a step of progressively raising the temperature up to the nucleation range, generally lying near the glass transformation range, a step of passing through the nucleation range for several minutes, a new progressive increase in the temperature up to the temperature of the ceramification stage, holding the temperature of the ceramification stage for several minutes, and then rapid cooling down to room temperature.

In the present invention, the process for obtaining the plate defined above advantageously comprises an operation of shaping the plate (which may be carried out at various moments during the abovementioned operating method, provided that the constituent material of the plate is at a high enough temperature for it to undergo plastic deformation) consisting, for example, of a sinking, molding or pressing operation (by rolling or by any other operation), with the use of one or more supports or one or more surfaces having the desired geometry, the ceramification of the plate generally taking place after or following the forming operation.

Preferably, a sinking-type forming operation (similar to that of document EP 0 879 797) is carried out in order to raise the edge of the opening (cutting of the opening generally taking place before the forming operation), during the ceramification cycle (generally before crystalline growth) of the glass plate. Particularly preferably, the raising is carried out by means of an element or bearing piece whose shape corresponds to that of the opening that is desired to obtain, this element being positioned on a forming support (for forming the other parts of the plate) and generally having a size slightly greater than that of the opening. Thus, during the ceramification cycle, the plate collapses under its own weight except at the point where it is held by the element, without it being necessary to use a specific tool.

The element for producing the raised feature may be hollow or solid and is advantageously chosen to be made of a ceramic material or a refractory steel. Preferably, the height of this element is equal to at least 2 mm, generally around 4 mm. Also preferably, each dimension (width, length and/or diameter) of the element is greater than the corresponding dimension of the opening by at least 5 mm. This element or bearing piece

may also be replaced with several elements or bearing pieces designed to occupy the same perimeter and fulfill the same role.

It is also possible to use other forming means, for example a molding or pressing means of forming, preceded and/or followed, where appropriate, by a cutting operation, for example using a water jet, optionally followed by a shaping operation.

The plate may also undergo other operations during its manufacture (for example deformations in order to produce protuberances, drilled holes for the subsequent incorporation of control elements, screen printing for indicating or esthetic purposes, the screen printing preferably taking place before ceramification so as to allow, where appropriate, the enamel to be baked during said ceramification, etc.) and it may be provided with added elements such as control elements or the hood as explained above. After the plates have been cut out, they may also be shaped (machined, beveled, etc.), before and/or after ceramification, for example by a buff wheel cooled at its center, in particular on at least part of their edges and/or of their openings, so as to avoid, for example, the presence of sharp edges that might injure users.

The subject of the present invention is also an apparatus (or device) for manufacturing a glass-ceramic plate as defined above, comprising at least one element or bearing piece for producing the raised feature as mentioned above.

Other details and advantageous features will become apparent below from the description of non-limiting embodiments of the invention with reference to the appended drawings in which:

- Figure 1 shows diagrammatically, in plan view, a plate according to the invention; and

- Figure 2 shows diagrammatically a cross section on the line A-A of the plate of figure 1, incorporated into a cooking appliance and in operation.

For the sake of clarity, the various parts have not necessarily been drawn to scale. The same references are used for similar parts.

The plate 1 is a glass-ceramic plate comprising at least four areas 2 defined, for example, by screen printing and indicating the heating areas intended to be above the heating means (not shown) incorporated into the cooking appliance 3 on which the plate is mounted, these heating means being, for example, in the present illustration, radiant or induction elements. The plate also includes at least one opening 4, such as defined according to the present invention, this opening being of rectangular shape

and having, for example, a width of around 11 cm for a length of around 30 cm and being in an approximately mid-way or central area of the plate. The opening is at the top of a local deformation of the plate, that is to say the edges 5 of the plate around the periphery of the opening are raised. Control elements 6 can allow the various members of the cooking appliance, such as the heating means, to operate.

In combination with the opening 4, a hood (shown schematically at 7) is provided beneath the plate 1 facing the opening. A metal support 8 with a mesh 9 closes off the opening in order to prevent objects falling through it, while allowing passage of the gases sucked out by the hood. When cooking food in a cooking vessel as shown schematically at 10, the cooking gases 11 are extracted by activating the hood as shown schematically by the arrows under the action in particular of a fan 12 and extracted via a duct (not shown). Advantageously, the hood is masked by the casing of the cooking appliance 3.

The plate is also equipped with one or more suitable seals 13, for example for sealing and/or providing the mechanical interface between the glass-ceramic plate and the associated elements.

The plates according to the invention may notably be used advantageously for producing a new range of plates for cookers or cooktops.